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Introduction

Energy is a critical component of every aspect of Washington's economy and is used daily by every resident of the state to meet the most basic human needs. Energy lights and heats our homes, cooks our food, fuels our vehicles, and powers our industries. Without it, our society would literally grind to a halt. But few of us have a thorough understanding of key trends taking place in this crucial industry. This section presents a series of 25 "Energy Indicators", illustrating some of the most important long-term energy trends. Each indicator consists of a chart based on readily available energy, economic, and demographic information, a caption highlighting key trends depicted in the chart, and narrative giving additional perspective or describing further aspects of the indicator.

The Energy Indicators are the successor to the *Washington State Energy Use Profile*, published periodically in the past by the Washington State Energy Office, most recently in June of 1996. They complete the evolution begun with the last *Profile* away from the dissemination of raw data, most of which is publicly available from other sources, towards a product that combines and interprets energy data in a format that is, we hope, more interesting and informative for policy-makers, the media, and the general public.

In order to ensure that the Energy Indicators presented here are grounded in the best available information and can be updated on a regular basis, they are based exclusively on regularly published data from sources in the public domain. The Energy Information Administration's *State Energy Data Report* and *State Energy Price and Expenditure Report* are the most complete sources of annual, state-level energy data. They form the foundation upon which the Energy Indicators are based. Unfortunately, collecting and publishing detailed statistics on energy consumption, price, and expenditures for fifty states and the District of Columbia is an enormous task, so information from these sources tends to lag by two to three years. Consequently, the Energy Indicators are confined to analysis of long-term energy trends.

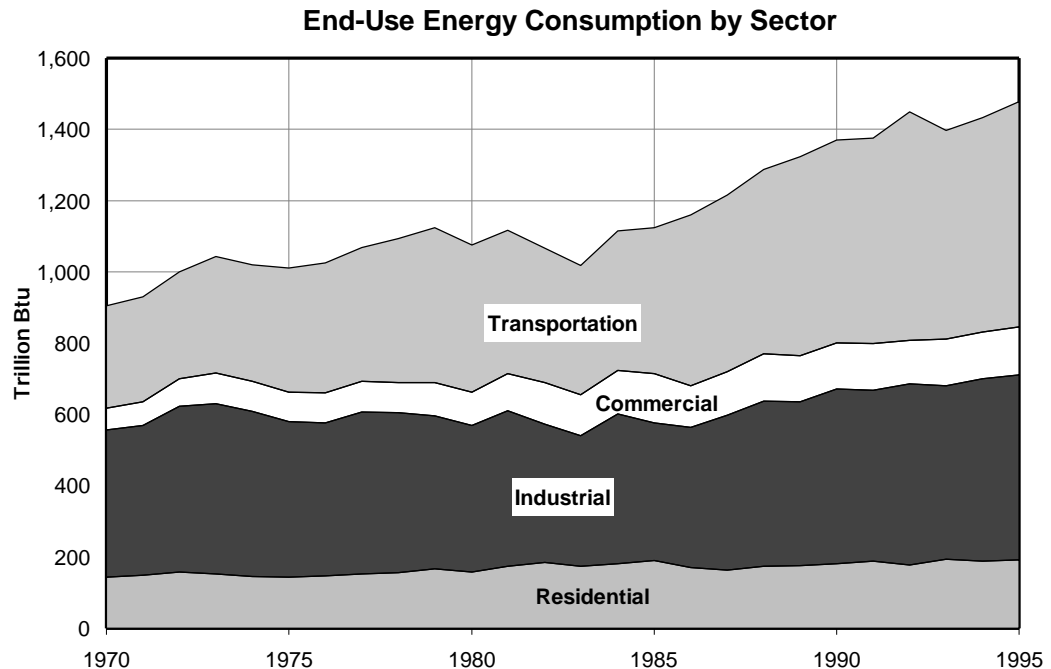
Additional sources of data employed in this report include the U.S. Commerce Department's Bureau of Economic Analysis and Bureau of the Census, the U.S. Department of Transportation's Federal Highway Administration and Bureau of Transportation Statistics, the U.S. Environmental Protection Agency, the Washington State University Energy Program, the Oak Ridge National Laboratory, and numerous additional EIA publications.

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1. Washington's Energy Use – End-Use Energy Consumption



Source: Energy Information Administration

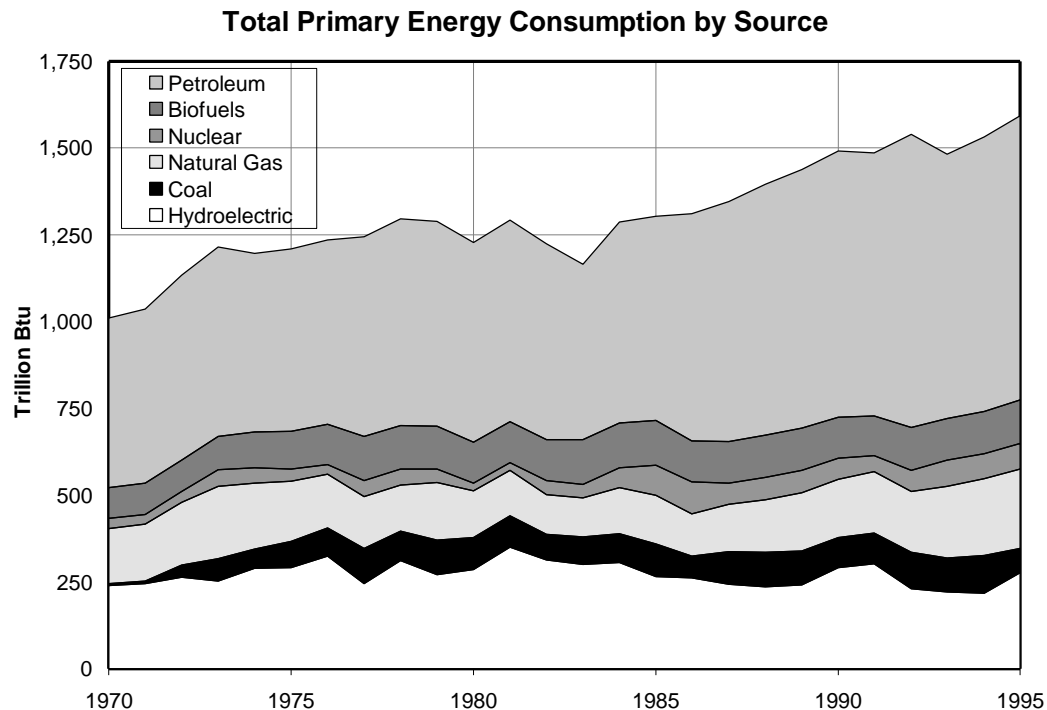
END USE ENERGY CONSUMPTION IN WASHINGTON WAS 63 PERCENT HIGHER IN 1995 THAN IN 1970. MOST OF THE INCREASE OCCURRED IN THE TRANSPORTATION SECTOR, WHERE ENERGY USE HAS MORE THAN DOUBLED SINCE 1970. TRANSPORTATION NOW ACCOUNTS FOR MORE THAN HALF OF THE STATE'S ENERGY CONSUMPTION.

Washington's end-use energy consumption grew at 2.8 percent per year between 1993 and 1995, reaching an all-time high of 1.5 quadrillion Btu in 1995. The transportation sector accounts for the largest share of growth in energy consumption, growing at an annual rate of 4.4 percent since 1985.

During the 1970s and early 1980s, growth in energy consumption was dampened by higher energy prices and changes in the state's economy. Industrial sector energy consumption declined by 6.5 percent between 1970 and 1985. Energy consumption in the commercial sector, which includes service industries such as finance, insurance, and real estate, more than doubled over the same period, but remains small relative to other sectors.

The period since 1985 has been characterized by resurgence in the industrial sector, where energy consumption grew at 3.1 percent per year between 1985 and 1995, and rapid growth in the transportation sector. After spiking in the late 1970s and early 1980s, energy consumption in the commercial and residential sectors has been flat since 1985.

2. Washington's Energy Use – Primary Energy Consumption



Source: Energy Information Administration

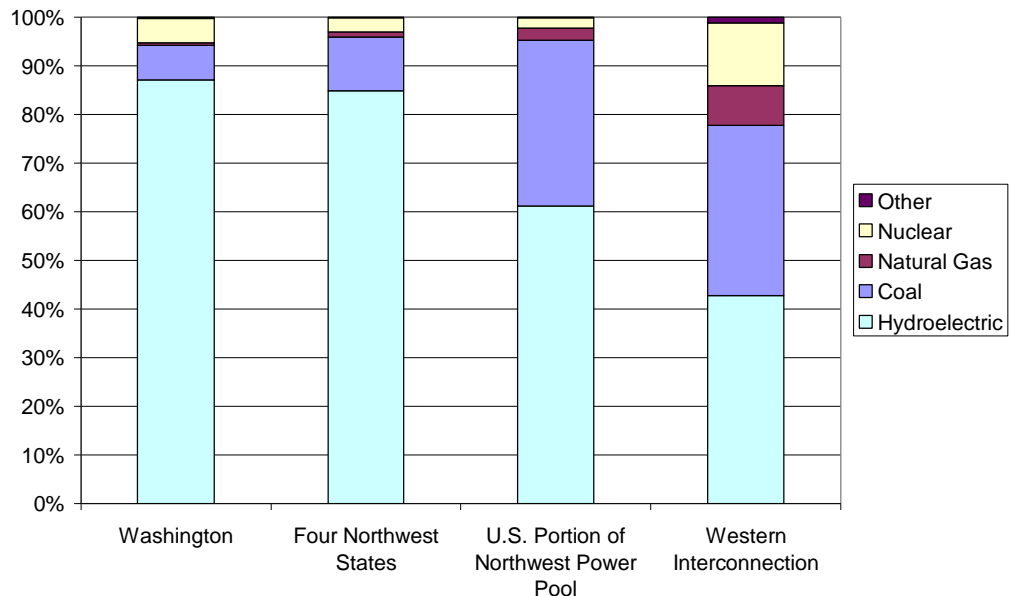
Data Note: EIA uses each state's mix of electric generation to map electricity consumption to production by primary fuels. This overstates the contribution of hydroelectricity, as Washington is part of an interconnected regional electric grid and relies on generation sources in other states that are less hydroelectric-intensive.

WASHINGTON CONTINUES TO RELY ON PETROLEUM FUELS TO MEET OVER HALF ITS ENERGY NEEDS. THE RELATIVE IMPORTANCE OF HYDROELECTRICITY AS AN ENERGY SOURCE HAS DECLINED.

This indicator shows the extent of Washington's reliance on six major primary energy sources: petroleum, hydroelectricity, natural gas, biofuels, coal, and uranium.¹ Washington continues to rely on petroleum, most of which is imported by tanker from Alaska, to meet over half of its primary energy needs. This share has not changed appreciably since 1970. Hydroelectricity's relative importance has declined since the mid 1980s, due to stable production and rapid growth in other fuels. Natural gas consumption doubled between 1983 and 1995, regaining the market share it lost during the 1970s. Natural gas now accounts for nearly 15 percent of Washington's primary energy consumption. Biofuels, mainly wood and wood waste products, account for 8 percent of primary energy consumption. These fuels are primarily burned for steam and cogeneration at pulp and paper mills. Coal is consumed almost exclusively at the Centralia Steam Plant, while uranium is used at the Washington Public Power Supply System's WNP-2 plant in Richland. Together, coal and nuclear generation accounted for 9 percent of Washington's primary energy supply in 1995.

3. Washington's Energy Use – Electricity Generation

1996 Electricity Generation by Fuel Type, Four Geographies



Source: Energy Information Administration

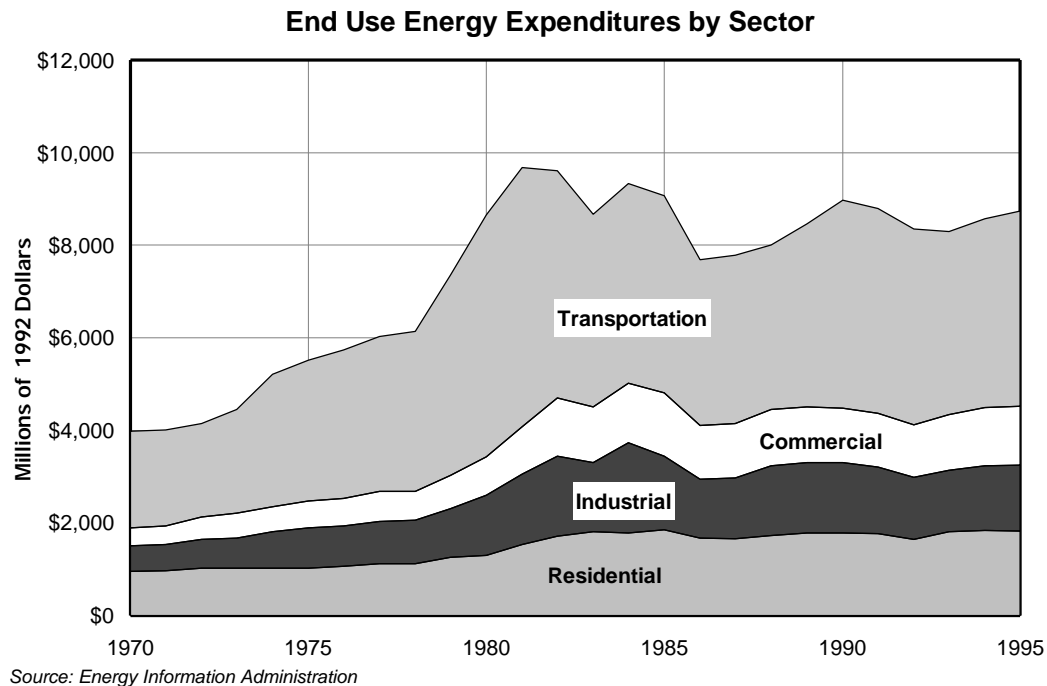
WHILE 85 PERCENT OF ELECTRICITY GENERATED IN WASHINGTON COMES FROM HYDROELECTRIC DAMS, WASHINGTON CONSUMERS ARE SERVED BY ELECTRICITY FROM GENERATING PLANTS LOCATED THROUGHOUT THE WESTERN INTERCONNECTION. MANY OF THESE PLANTS ARE FIRED BY COAL OR NATURAL GAS.

How much of Washington's electricity is hydro? The answer depends on how one defines "Washington's electricity". While hydroelectric dams accounted for 85 percent of the electricity generated in Washington in 1996, Washington is part of an interconnected, regional bulk power system and Washington consumers are dependent on coal, natural gas, and nuclear plants in other states. Moreover, much of the hydroelectric generation in Washington is owned by the federal government and operated on behalf of customers in multiple states.

A better proxy for "Washington's electricity" might be the mix of generation in the U.S. portion of the Northwest Power Pool (NWPP)². This incorporates coal plants in Oregon, Montana, Wyoming, and Utah owned by utilities that serve Washington customers. Hydroelectric dams accounted for 61 percent of NWPP generation in 1996, while 34 percent came from coal-fired plants.

However, this still ignores seasonal purchases of nuclear, coal and gas-fired electricity from the Southwest. The 1996 generation mix for the U.S. portion of the Western Interconnection³ was 43 percent hydro, 35 percent coal, 13 percent nuclear, and 8 percent natural gas.

4. Washington's Energy Bill – End Use Energy Expenditures

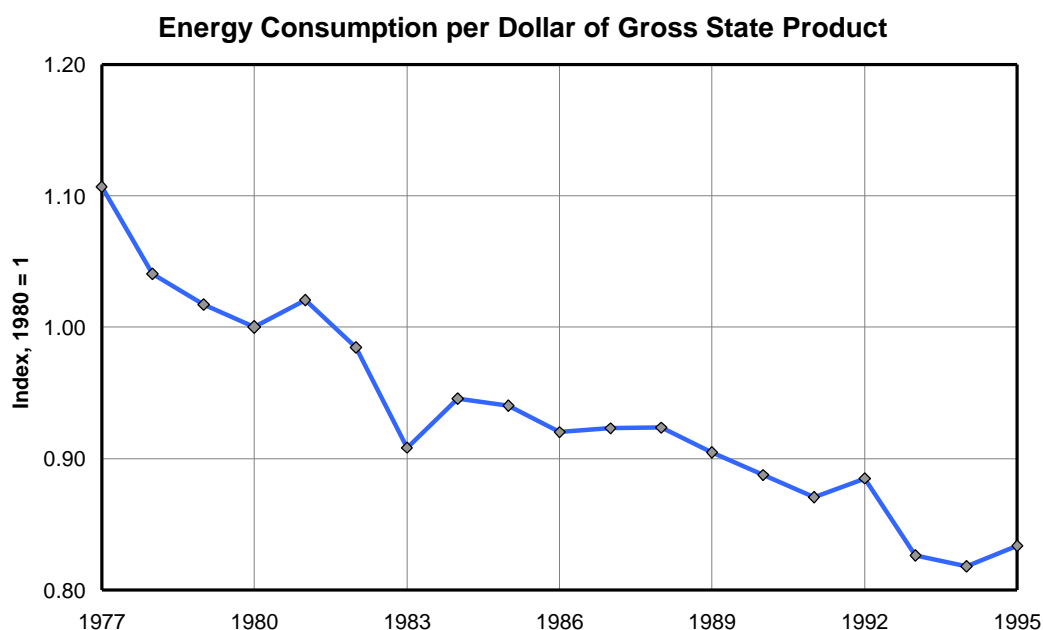


ADJUSTED FOR INFLATION, ENERGY EXPENDITURES IN WASHINGTON IN 1995 ARE SIMILAR TO 1980, DESPITE A 37 PERCENT INCREASE IN ENERGY CONSUMPTION DURING THAT PERIOD.

Washingtonians spent \$9.4 billion on energy in 1995. While that represents a 60 percent increase over 1980 in nominal terms, when adjusted for inflation the amounts are approximately the same, despite a 37 percent increase in energy consumption. Energy prices have not kept pace with inflation since oil prices peaked in the early 1980s. This period contrasts sharply to the 1970s, when expenditures on energy increased by 150 percent in real terms.

The transportation sector accounts for the largest share of energy expenditures, nearly 50 percent in 1995. This proportion declined, however, from 60 percent in 1980, even as transportation's share of statewide energy consumption increased. The real price of petroleum fuels has declined significantly since 1980, while the price of electricity, the largest energy source in the residential and commercial sectors, has stayed constant.

5. Washington's Energy Intensity – Energy Consumption per Dollar of GSP



Sources: Energy Information Administration, Bureau of Economic Analysis

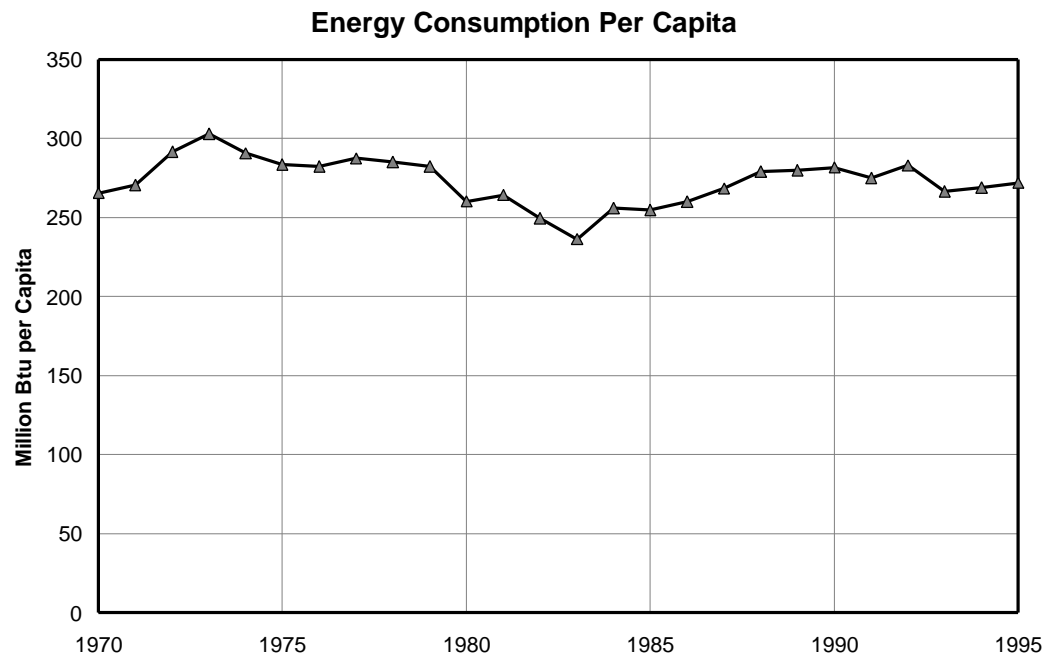
Data Note: Irregularities in 1983 and 1992 are caused by volatility in certain petroleum fuels, particularly residual fuel, which is often purchased in bulk and used over longer periods of time.

WASHINGTON CONTINUES TO PRODUCE MORE GOODS AND SERVICES PER UNIT OF ENERGY CONSUMED, DESPITE GROWTH IN TOTAL ENERGY CONSUMPTION. KEY REASONS ARE A SHIFT IN THE STATE'S ECONOMY TO LESS ENERGY-INTENSIVE INDUSTRIES AND IMPROVED PROCESS EFFICIENCY.

This report presents several measures of Washington's energy intensity, the extent to which the state relies on energy to fuel its economy and meet its everyday needs. The first measures the energy intensity of Washington's economy, by depicting the amount of energy we use to produce a dollar's worth of economic output. Washington energy consumption is divided by Gross State Product (GSP), the sum of all goods and services produced in the state, and the result is indexed so that the value in 1980 is equal to 1. Despite the rapid increase in Washington's total energy consumption between 1980 and 1995, energy consumption per dollar of GSP declined by 17 percent over the period.

Washington's economy is growing faster than its energy consumption, and has been since at least 1977, when the Gross State Product data series we use begins. This is due to a number of factors, chief among them a shift in the state's economy from its resource and manufacturing base to software, biotech, and other, less energy intensive industries. Gains in energy efficiency have also contributed.

6. Washington's Energy Intensity – Energy Consumption per Capita

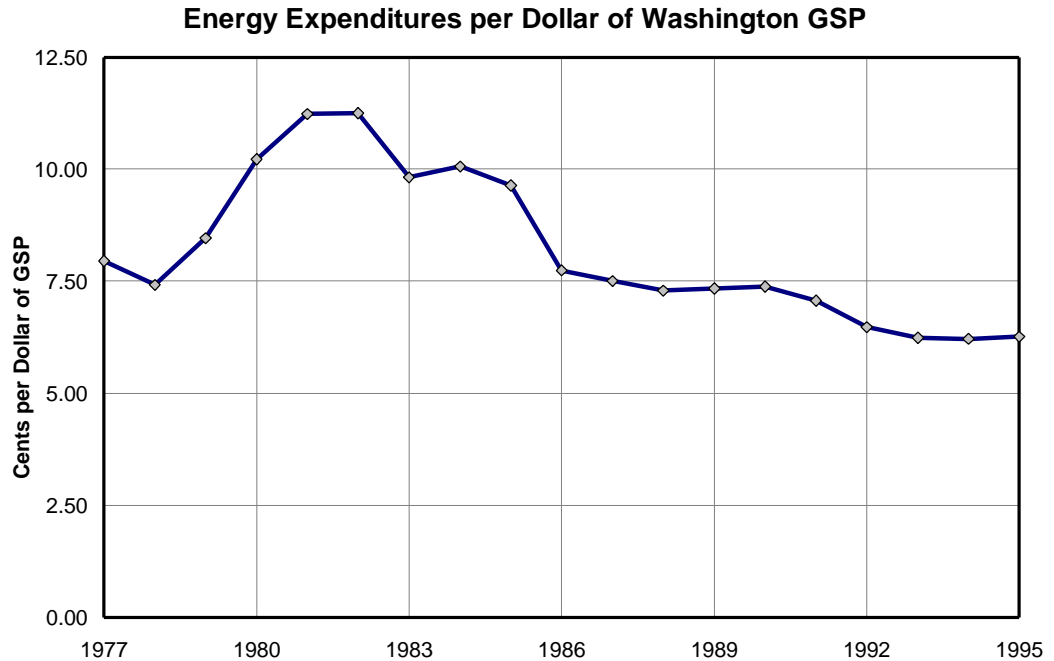


Sources: Energy Information Administration, Bureau of the Census

ENERGY CONSUMPTION PER CAPITA IS SIMILAR TODAY TO LEVELS IN 1970. PER CAPITA CONSUMPTION REACHED A LOW IN 1983, BUT GROWTH IN TRANSPORTATION ENERGY CONSUMPTION HAS LED TO STEADY INCREASES SINCE THEN.

Another way to look at Washington's energy intensity is energy consumption per capita. While the previous indicator demonstrated that Washington continues to create more wealth per unit of energy, here the story is somewhat different. Washington's per capita energy consumption in 1995 was 272 million Btu. That's the equivalent of approximately 2,200 gallons of gasoline per person, and is identical to the figure for 1971. Energy consumption per capita declined after 1973 to a low of 236 million Btu per person in 1983, a decline of 21 percent. This was followed by a period of rapid growth between 1983 and the end of the decade. Most of the increase occurred in transportation fuels, as communities began to sprawl and Washingtonians drove more and more miles per year.

7. Washington's Energy Intensity – Energy Expenditures and Gross State Product

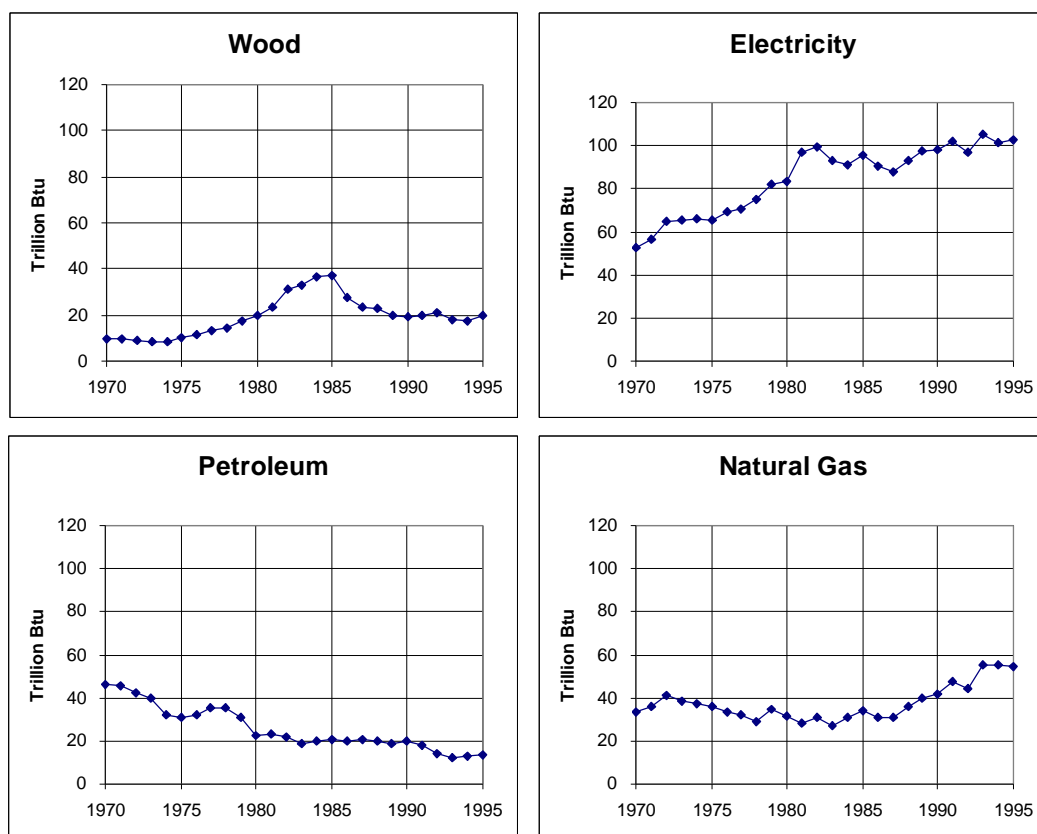


Data Note: These figures include both household consumption and personal transportation.

ENERGY EXPENDITURES ARE DECLINING RELATIVE TO ECONOMIC OUTPUT, DESPITE GROWTH IN ENERGY CONSUMPTION. PRINCIPAL CAUSES ARE DECLINING ENERGY INTENSITY AND LOWER ENERGY PRICES.

This indicator divides statewide energy expenditures by economic output, in the form of Gross State Product. The result is an estimate of the significance of energy in Washington's economy. Approximately 6.3¢ is spent on energy in Washington for every dollar of gross state product. This number has been declining steadily since peaking at nearly 12¢ in 1982. Two trends have contributed to this decline: Washington's economy is becoming less energy-intensive and energy prices have declined. Today, energy expenditures are smaller relative to Washington's economy than at any time in history.

8. Residential Sector Trends – End-Use Energy Consumption by Fuel



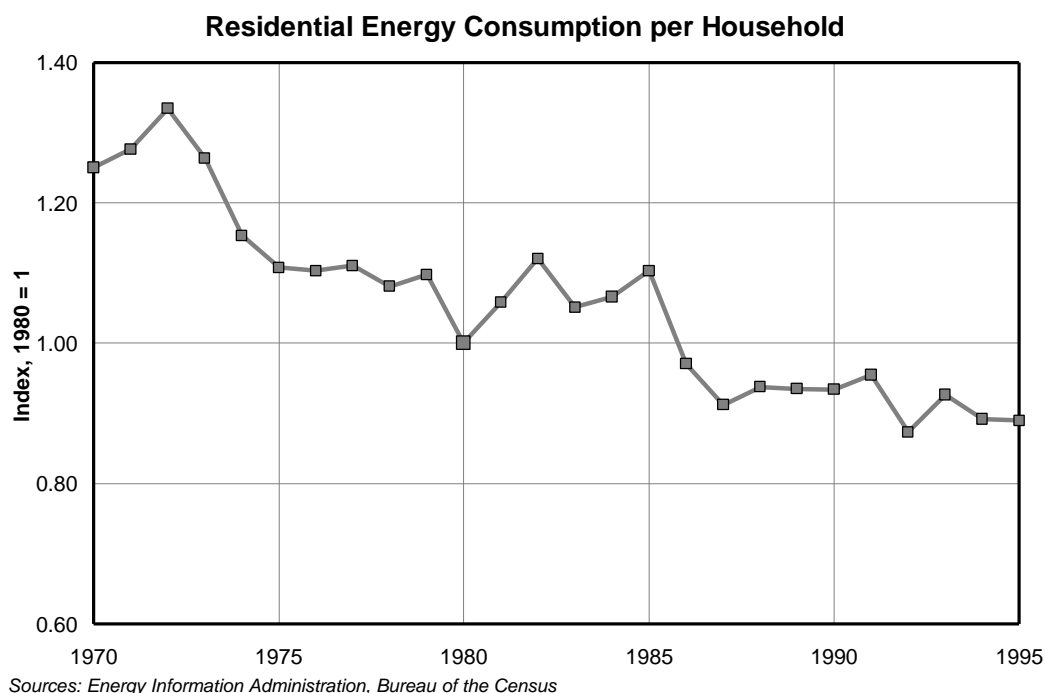
Source: Energy Information Administration

GROWTH IN HOUSEHOLD ELECTRICITY CONSUMPTION HAS SLOWED IN THE LAST 15 YEARS, WHILE GROWTH IN NATURAL GAS USE HAS ACCELERATED. WOOD AND OIL CONSUMPTION CONTINUE TO DECLINE.

Electricity accounts for the majority of residential energy consumption, but average electricity use per household has declined since 1980. Growth in natural gas consumption has accelerated; residential sector gas use grew at 1.9 percent per year between 1980 and 1985, 3.9 percent per year between 1985 and 1990, and 5.7 percent per year between 1990 and 1995.

Consumption of firewood grew in the late 1970s and early 1980s in response to high heating oil prices. Environmental restrictions and the increasing popularity of gas appliances have contributed to declining wood consumption in the last ten years. Home heating oil consumption continues to fall, from 300 gallons per household in 1970 to less than 50 gallons in 1995.

9. Residential Sector Trends – Household Energy Intensity

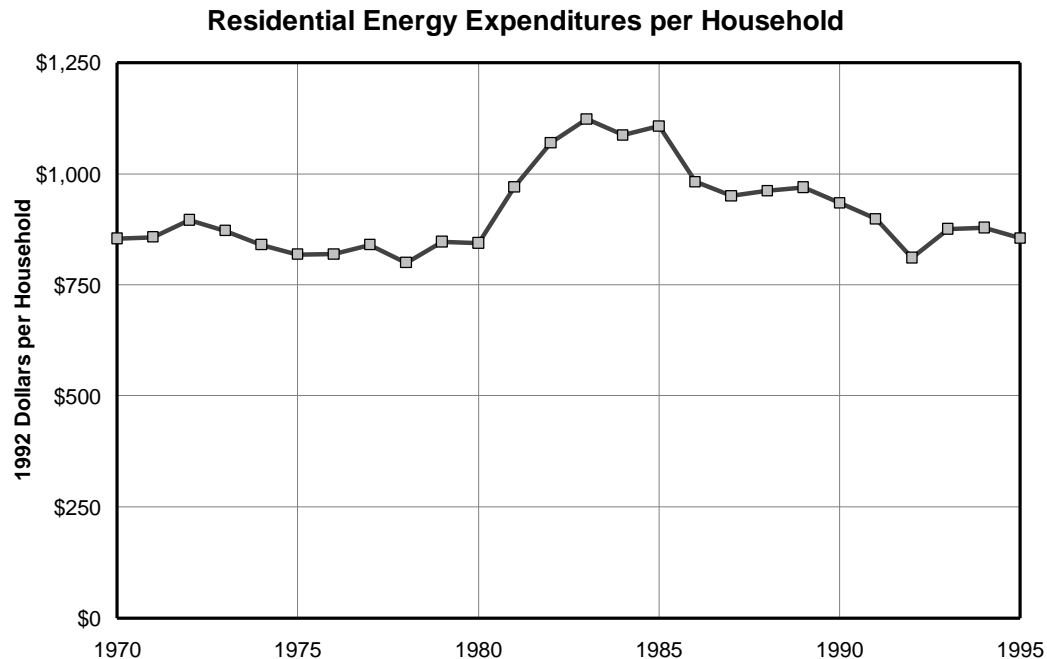


ENERGY CONSUMPTION PER WASHINGTON HOUSEHOLD HAS DECLINED BY MORE THAN A THIRD SINCE PEAKING IN 1972, SUGGESTING AN IMPROVEMENT IN HOUSEHOLD ENERGY EFFICIENCY. GAINS HAVE SLOWED IN RECENT YEARS.

Washington households continue to become more energy efficient. Energy consumption per household has declined by nearly 20 percent since 1985, a rate of 2.1 percent per year. The 1970s were characterized by declining oil and natural gas consumption, with gas use per household falling by 33 percent between 1970 and 1980. Oil consumption dropped from 300 gallons per household in 1970 to 85 in 1983, with half the decline occurring after the second oil shock in 1978. A number of households may have switched to wood as a primary source of space heating during this time. Electricity consumption per household began to decline in the early 1980s after decades of growth. Despite larger houses and the recent proliferation of electricity-using appliances, electricity consumption per household declined by 14 percent between 1985 and 1995.

The trend toward lower household energy consumption has slowed recently, as declines in wood and petroleum consumption during the 1990s have been offset by increasing natural gas consumption. Moreover, these data do not include energy used for personal transportation, which has increased markedly during the last fifteen years.

10. Residential Sector Trends – Household Energy Bill



Sources: Energy Information Administration, Bureau of the Census

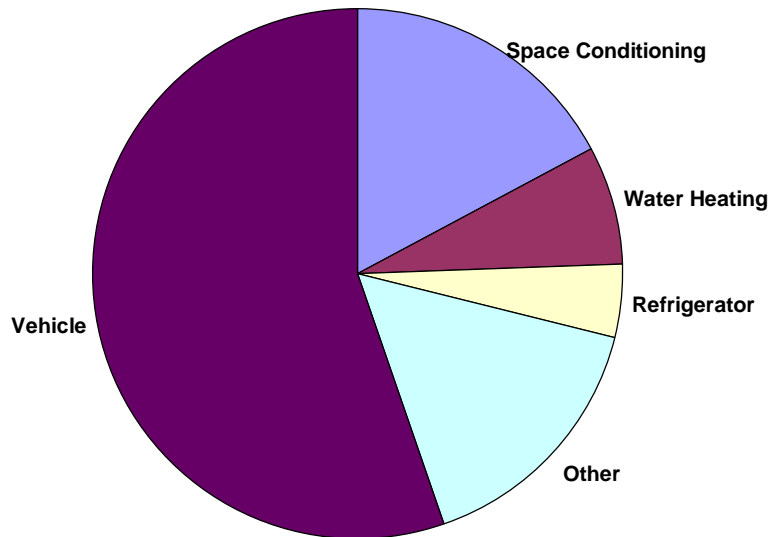
ADJUSTED FOR INFLATION, THE AVERAGE WASHINGTON HOUSEHOLD SPENT THE SAME AMOUNT FOR HOME ENERGY IN 1995 AS IN 1970. IMPROVEMENTS IN HOUSEHOLD ENERGY EFFICIENCY AND FUEL SWITCHING TO LESS EXPENSIVE FUELS HAVE OFFSET HIGHER ELECTRICITY PRICES.

In 1995, the average Washington household spent the inflation-adjusted sum of \$872 for electricity, natural gas and petroleum delivered to the home, identical to the figure in 1970. This outward similarity masks significant changes in the composition of household energy expenditures over the last 25 years. Increased emphasis on energy conservation and fuel-switching from heating oil to wood (much of which is harvested free of charge) helped to mitigate the impact of the oil shocks of the 1970s on the home energy bill of Washington households. However, there is no immediate substitute for electricity, so when electricity prices increased by 62 percent between 1980 and 1983, due largely to the inclusion in rates of the WPPSS nuclear bonds, the average household electricity bill increased by a like amount.

Over the long run, energy efficiency and fuel-switching have helped reduce household consumption of relatively expensive electricity. The electricity bill for the average Washington household dropped by 18 percent between 1985 and 1995; usage per household fell 14 percent. Many households saved by switching to natural gas; the average gas bill fell by 17 percent between 1985 and 1995, despite a 27 percent increase in per household consumption.

11. Residential Sector Trends – Household Energy Bill with Transportation

Household Energy Bill by End Use 1993
(\$2,000)



Source: Energy Information Administration, Residential Energy Consumption Survey

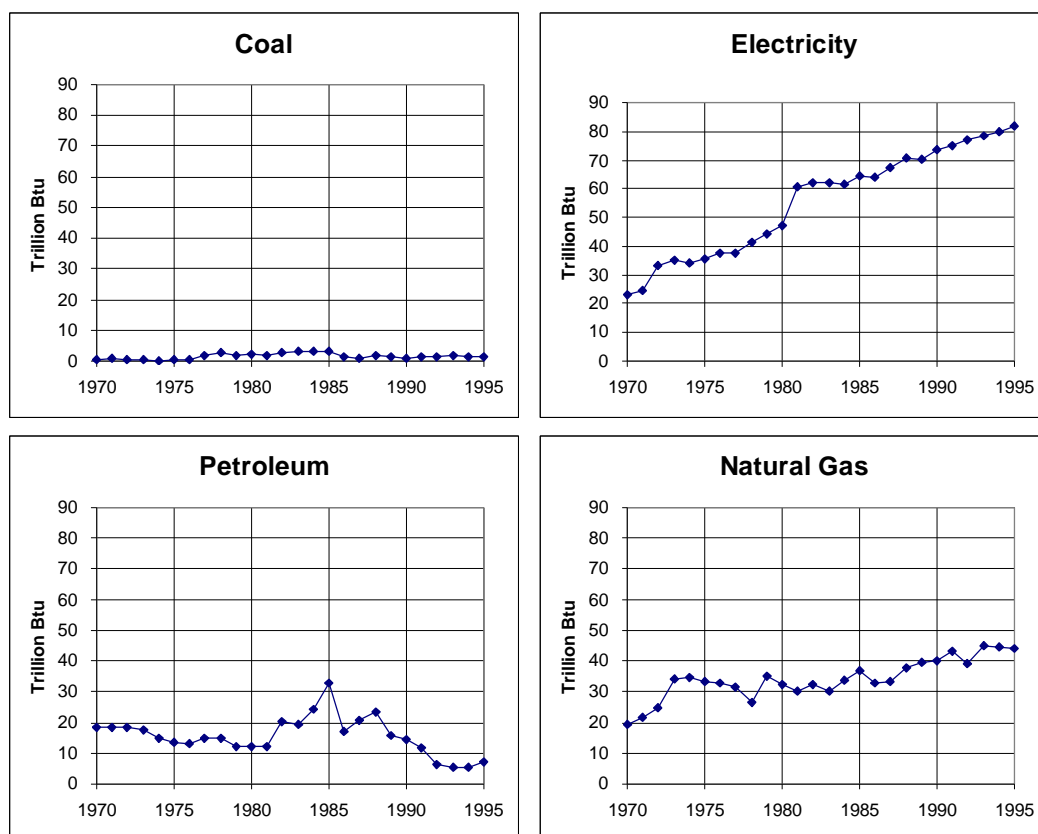
Data Note: These detailed figures about household energy expenditures were obtained from a different source than data used elsewhere in this report. As a result, this estimate of the average household energy bill differs slightly from that in the previous indicator.

INCLUDING ENERGY USED FOR PERSONAL TRANSPORTATION MORE THAN DOUBLES THE ANNUAL ENERGY BILL FOR THE AVERAGE WASHINGTON HOME.

The average household in Washington spent 55 percent of its energy budget fueling vehicles for transportation in 1993. This share has increased dramatically in the last two decades. While homes are becoming more energy efficient, they are increasingly located at large distances from where people work, shop, and recreate.

After personal transportation, major categories of household energy expenditures include space conditioning (heating, cooling, and ventilation), water heating, refrigerators, lighting, household appliances, and electronic equipment.

12. Commercial Sector Trends – End-Use Energy Consumption by Fuel

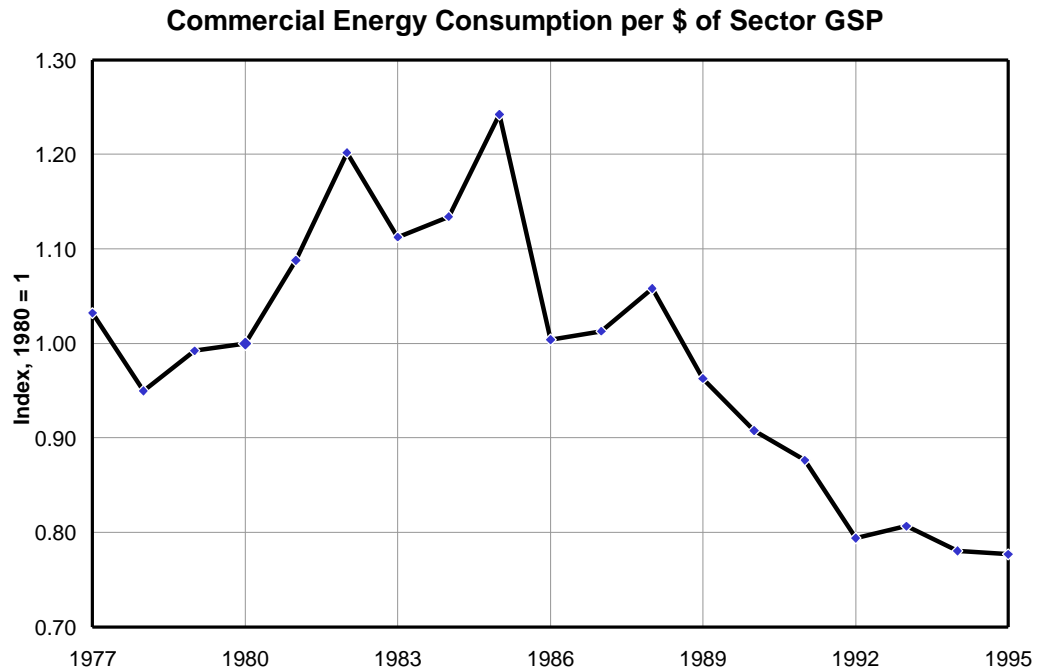


Source: Energy Information Administration

ELECTRICITY ACCOUNTS FOR OVER 60 PERCENT OF END-USE ENERGY CONSUMPTION IN THE COMMERCIAL SECTOR. NATURAL GAS MAKES UP THE BULK OF THE REST. BOTH GAS AND ELECTRICITY CONSUMPTION CONTINUE TO GROW AT 2 PERCENT PER YEAR.

Electricity and natural gas are the dominant fuels in Washington's commercial sector. With escalating use of electricity-consuming equipment such as computers, printers, and photocopiers, the commercial sector has become increasingly reliant on electricity during the last two decades. Commercial sector electricity consumption has nearly quadrupled since 1970. Natural gas lost market share in the late 1970s and early 1980s, but has recovered rapidly since 1985. In contrast, petroleum consumption is less than half of early 1970s levels, declining from 30 percent of commercial energy consumption in 1970 to around 5 percent in 1995.

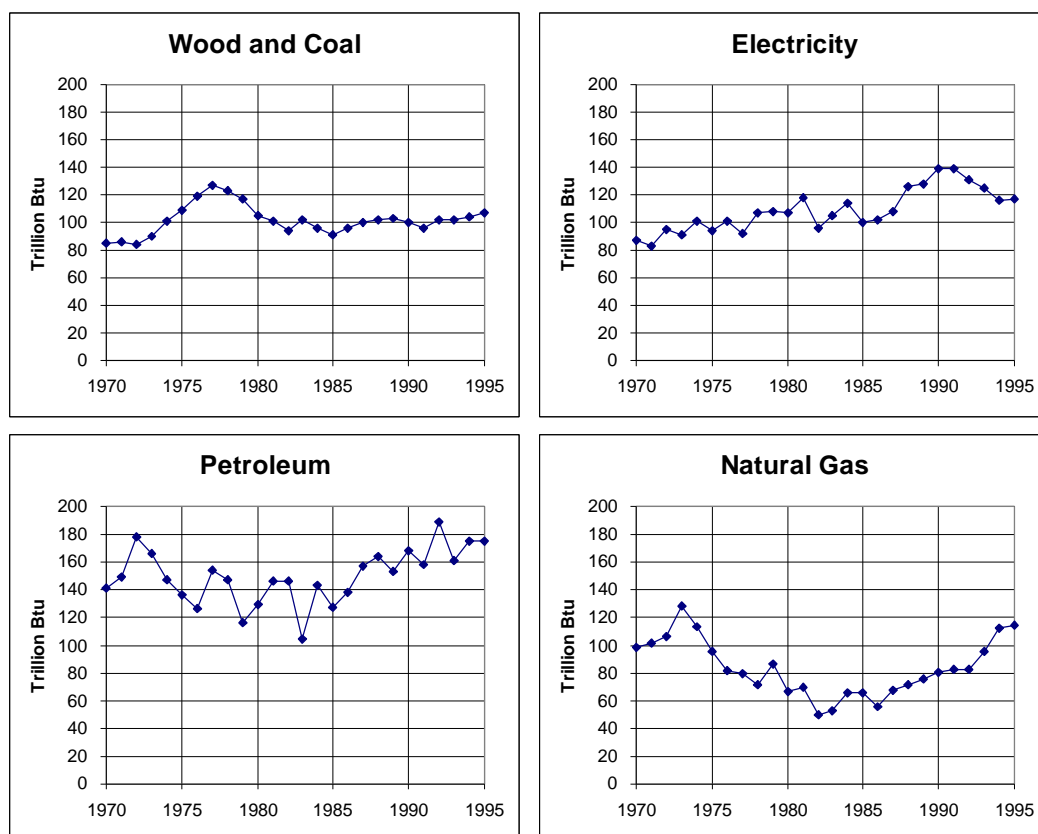
13. Commercial Sector Trends – Commercial Sector Energy Intensity



COMMERCIAL SECTOR ENERGY CONSUMPTION HAS DECLINED RAPIDLY RELATIVE TO ECONOMIC OUTPUT SINCE THE MID-1980S.

Washington's commercial sector has become much less energy intensive over the last 15 years. Commercial sector energy consumption increased more than 50 percent between 1977 and 1985, but has since declined slightly. Meanwhile, the value of all goods and services produced by the commercial sector has more than doubled in real terms since 1977 and continues to grow at 4 percent per year. Increased productivity and improvements in the efficiency of buildings, lighting, and equipment have played a major role in declining commercial sector energy intensity.

14. Industrial Sector Trends – End-Use Energy Consumption by Fuel



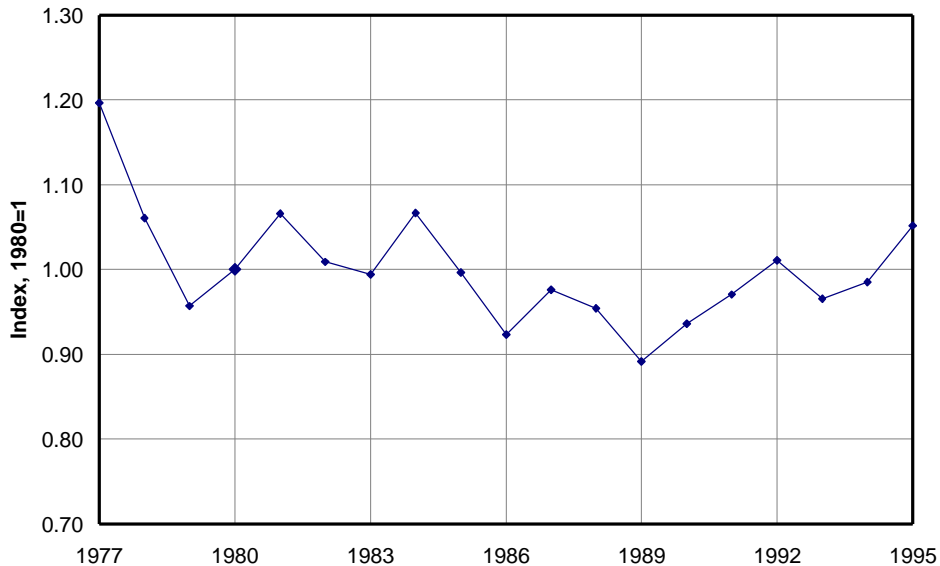
Source: Energy Information Administration

INDUSTRIAL ENERGY CONSUMPTION IN WASHINGTON IS SPLIT FAIRLY EVENLY BETWEEN BIOFUELS, ELECTRICITY, PETROLEUM AND NATURAL GAS. AS IN OTHER SECTORS, GROWTH IN NATURAL GAS CONSUMPTION HAS ACCELERATED DURING THE 1990s.

Unlike the residential and commercial sectors, which rely primarily on electricity and natural gas, or the transportation sector which consumes almost exclusively petroleum fuels, energy consumption in Washington's industrial sector is quite diversified. Biofuels, electricity, petroleum, and natural gas each accounted for over 20 percent of industrial sector energy consumption during 1995. With the exception of natural gas, the relative market share of each of the fuels has not changed dramatically since 1970. Natural gas consumption declined precipitously between 1973 and 1983, but growth has accelerated in recent years. Industrial natural gas consumption grew 4.2 percent between 1985 and 1990, and 7.2 percent between 1990 and 1995.

15. Industrial Sector Trends – Industrial Sector Energy Intensity

Industrial Sector Energy Consumption per \$ of Sector GSP

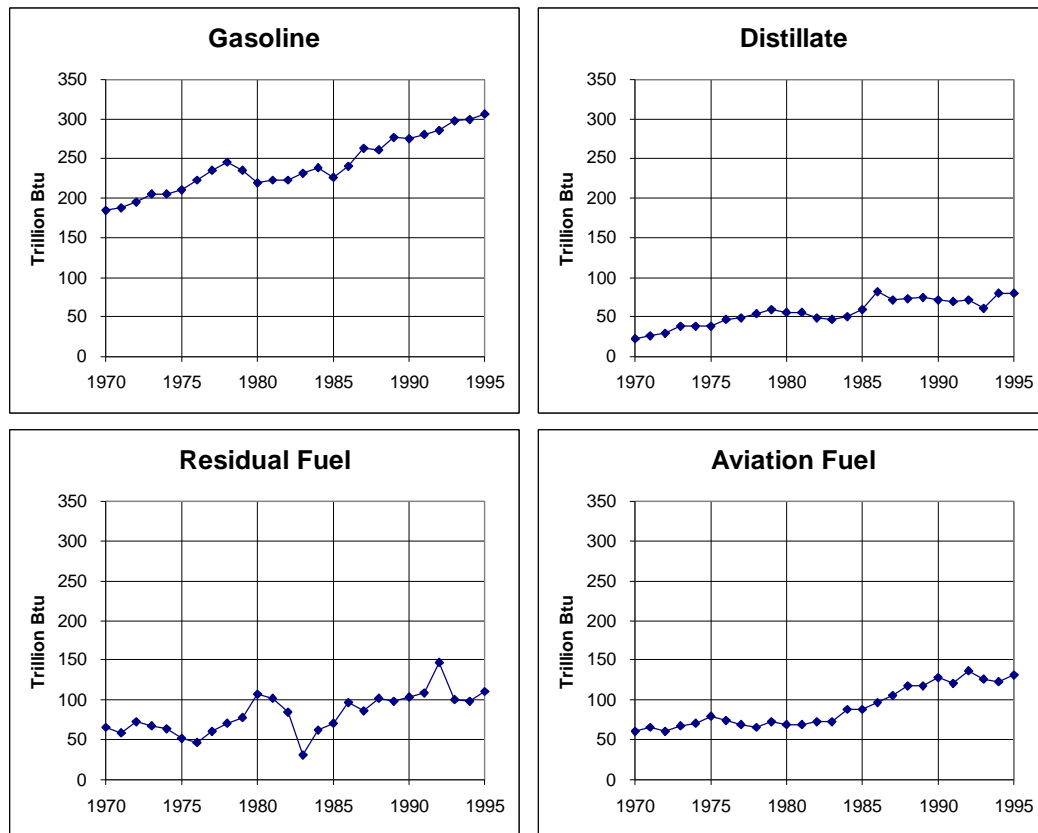


Sources: Energy Information Administration, Bureau of Economic Analysis

ENERGY INTENSITY IN WASHINGTON'S INDUSTRIAL SECTOR EXHIBITS LITTLE LONG-TERM TREND.

Unlike other sectors, Washington's industrial sector does not appear to have become less energy intensive during the last two decades. While natural gas use grew by 74 percent between 1980 and 1995, consumption of electricity, petroleum and biofuels showed little indication of any long-term trend. Both energy consumption and industrial production are extremely volatile, making it difficult to discern underlying trends. Industrial production contracted 15 percent between 1979 and 1985, then grew by 35 percent between 1985 and 1990 before leveling off at approximately \$30 billion per year in constant, 1992 dollars. Energy consumption in the industrial sector can vary by as much as 10 percent from one year to the next.

16. Transportation Sector Trends – End-Use Energy Consumption by Fuel



Source: Energy Information Administration

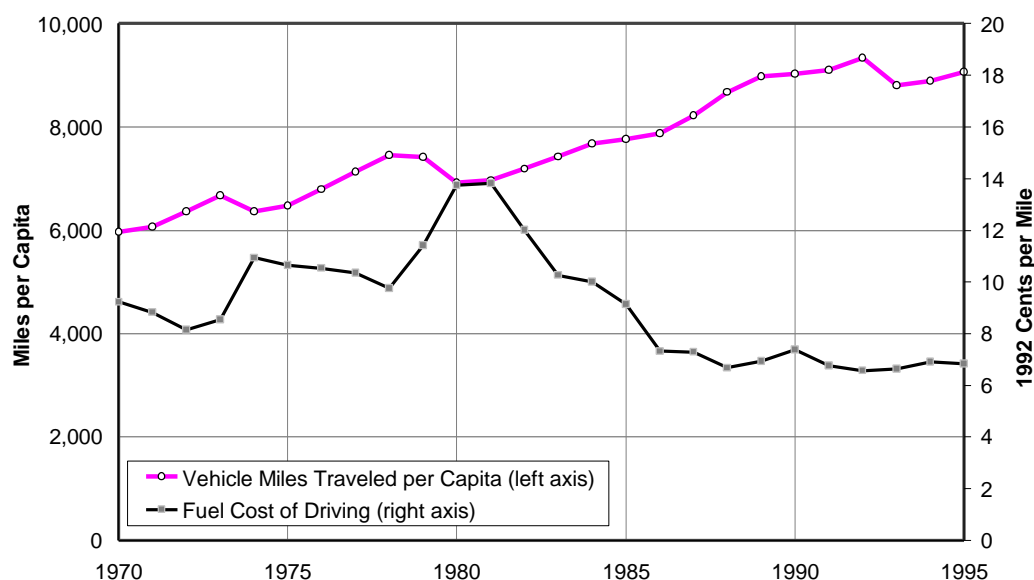
GASOLINE ACCOUNTS FOR HALF OF TRANSPORTATION SECTOR ENERGY USE IN WASHINGTON. WHILE WASHINGTONIANS DRIVE MORE THAN OTHER AMERICANS, WASHINGTON'S STATUS AS A MAJOR SEAPORT AND AVIATION HUB MEANS HIGHER CONSUMPTION OF AVIATION AND MARINE FUELS AS WELL.

Motor gasoline is the dominant transportation fuel, accounting for approximately half of Washington's transportation energy consumption. Except for the period between 1978 and 1986, demand for travel has outstripped gains in vehicle fuel efficiency, leading to steady growth in gasoline consumption. Consumption of motor fuels in boats and ships, airplanes, and railroads has shown growth paralleling that of on-road uses. Residual fuel, used for vessel bunkering, is subject to price-induced volatility, because it can be stored for long periods of time without degrading, leading to large swings in sales during times of high or low prices.

Jet fuel consumption most closely resembles the overall transportation trends. Declining jet fuel prices have contributed to a significant increase in air travel, overwhelming efficiency improvements in the stock of private, commercial, and military planes. Jet fuel use more than doubled between 1970 and 1995, growing at an average annual rate of 3.2 percent.

17. Transportation Sector Trends – Fuel Cost of Driving and Miles Driven

Fuel Cost of Driving and Miles Driven per Capita



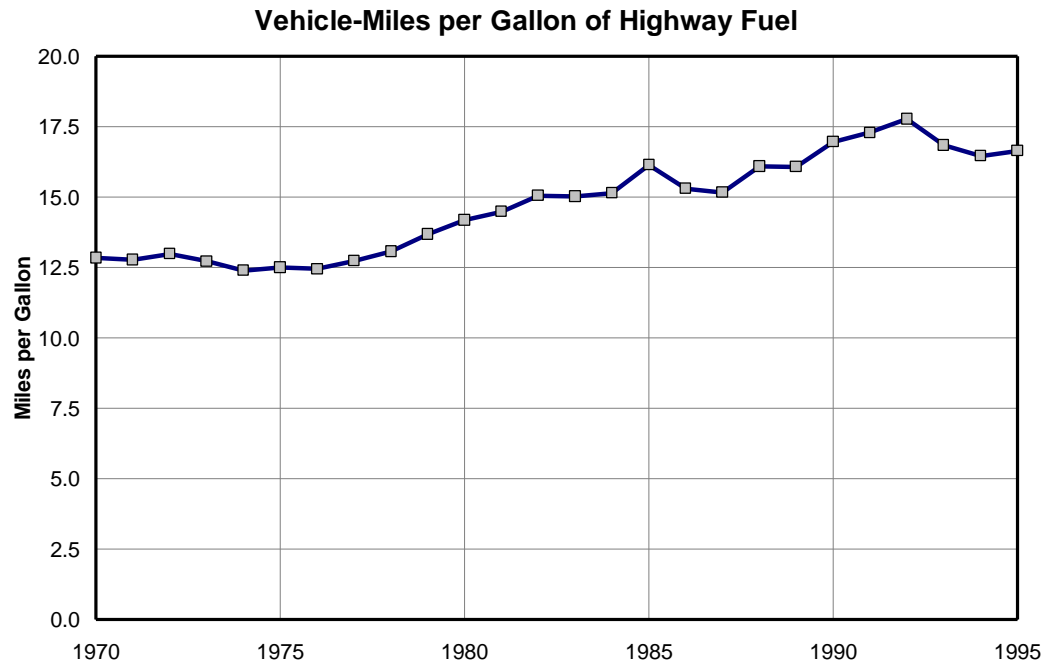
Sources: Energy Information Administration, Bureau of the Census, Federal Highway Administration

WASHINGTONIANS DROVE 50 PERCENT MORE MILES PER CAPITA IN 1995 THAN THEY DID IN 1970. A BIG REASON IS THE FUEL COST OF DRIVING, WHICH REMAINS AT HISTORIC LOWS.

This indicator juxtaposes the fuel cost of driving with miles per driven per capita in Washington. Not surprisingly, these series exhibit a strong inverse relationship. The fuel cost of driving, calculated as real dollar highway energy expenditures divided by vehicle-miles traveled (VMT), spiked upward in 1974 and 1979-1980 as a result of the oil shocks. VMT per capita dropped slightly in response to higher prices, as people temporarily curtailed unnecessary driving. However, long-term factors such as land-use patterns, commuting habits, and the long lifetimes of vehicles mean that large swings in fuel prices lead to only small changes in miles driven.

Increasing sales of more fuel-efficient vehicles in the early 1980s combined with declines in the price of highway fuels to cause a rapid drop in the fuel cost of driving, from a high of 13.8¢ per mile in 1981 to 7.3¢ in 1986 (in 1992 dollars). Gains in fuel efficiency since the early 1970s made this the lowest value in history. However, real gasoline prices have changed little since 1986, and increases in vehicle fuel efficiency have slowed dramatically as well. Meanwhile, vehicle travel increased steadily before falling off in 1993.

18. Transportation Sector Trends – Transportation Sector Energy Intensity



Sources: Energy Information Administration, Federal Highway Administration

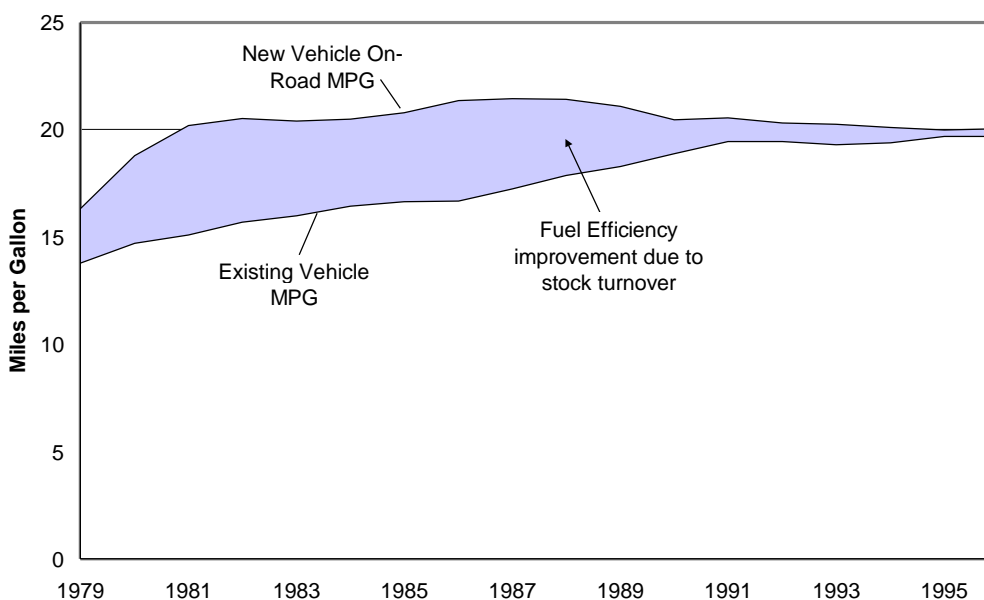
Data Note: Includes heavy-duty trucks.

SPURRED BY HIGH GASOLINE PRICES, VEHICLE FUEL EFFICIENCY INCREASED BY MORE THAN A THIRD BETWEEN 1975 AND 1985. INCREASING POPULARITY OF VANS, TRUCKS, AND SPORT UTILITY VEHICLES IN THE 1990S MAY HAVE PUT AN END TO THAT TREND.

Like other sectors, Washington's transportation sector has become more energy efficient over the years. The average efficiency of Washington's vehicle fleet grew from 12.5 miles per gallon in 1975 to 14.2 MPG in 1980 and 17.0 MPG in 1990. However, fifteen years of improvements in vehicle fuel efficiency appear to have come to an end in the 1990s. In fact, fuel efficiency for new vehicles has declined since the mid-1980s, when federal fuel standards were last tightened. The primary reason is the increasing popularity of minivans, pickups, and sport-utility vehicles.

19. Transportation Sector Trends – U.S. Vehicle Fuel Efficiency

U.S. Vehicle Fuel Efficiency Trends, 1979-1996



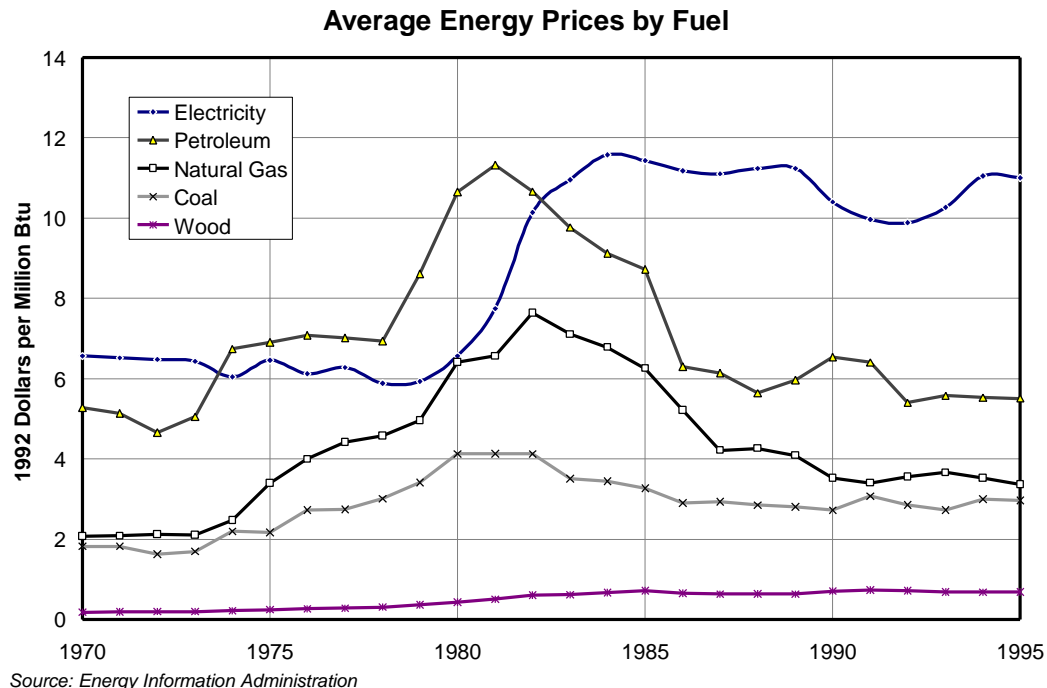
Source: Energy Information Administration, Oak Ridge National Laboratory

THE FUEL EFFICIENCY ADVANTAGE OF NEW VEHICLES RELATIVE TO THE EXISTING VEHICLE FLEET IS DISAPPEARING. INCREASING POPULARITY OF LARGER VEHICLES, COMBINED WITH THE AGING OF 1980S-ERA SUBCOMPACTS, MAY MEAN AN END TO YEARS OF FUEL EFFICIENCY IMPROVEMENTS.

The difference between the fuel efficiency of new vehicles and that of the nation's existing vehicle fleet continues to shrink and may even have disappeared. New vehicle fuel efficiency has been declining since the mid-1980s, when Congress last increased Corporate Average Fuel Economy (CAFE) standards. CAFE standards require companies to maintain the average fuel efficiency of new vehicles at around 28 MPG for cars and 21 MPG for light trucks (which includes minivans, pickups, and sport-utility vehicles).⁴ However, CAFE has no mandates about how many vehicles may be sold in each category, and the increasing popularity of light trucks has caused the fuel efficiency of the average new vehicle to drop by two miles per gallon since 1988.

Moreover, the vehicles being replaced are no longer 1970s-era gas guzzlers, but are frequently compact, fuel-efficient, cars of the 1980s. The result is that, unlike in other sectors where newer equipment tends to be more energy efficient, vehicle stock turnover may be leading to a less efficient national fleet. With the average lifetime of light-duty vehicles being more than seven years and no end in sight to increasing demand for travel, Washington petroleum consumption will continue to increase for some years.

20. Energy Price Trends – Average Energy Prices by Fuel

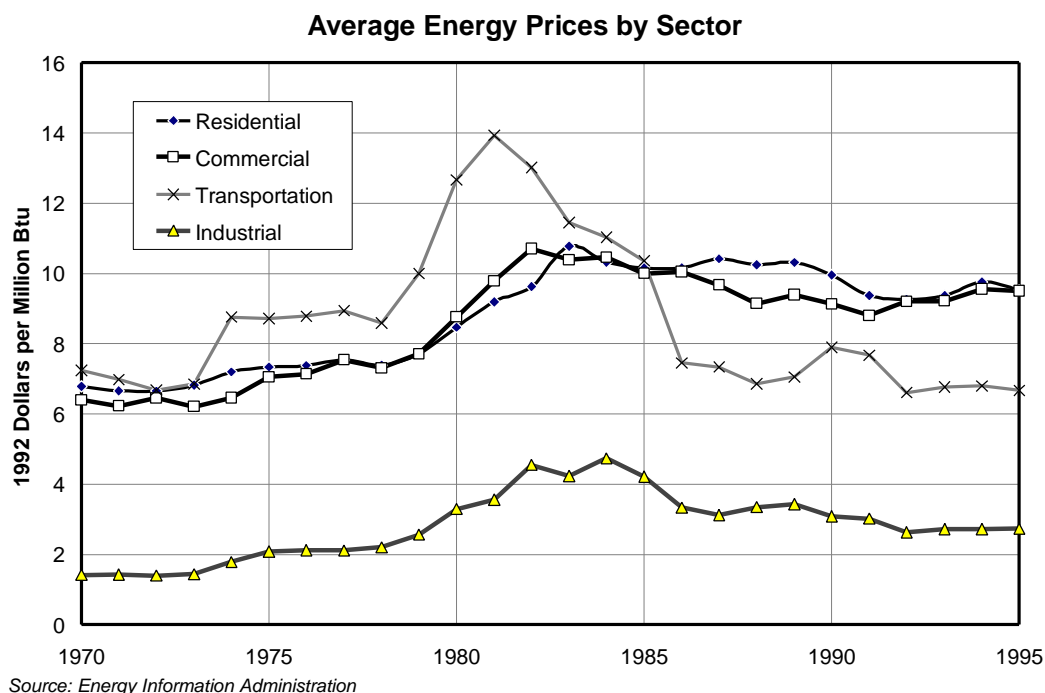


EVEN THOUGH ELECTRICITY PRICES IN WASHINGTON TEND TO BE LOWER THAN IN OTHER PARTS OF THE COUNTRY, ELECTRICITY IS STILL THE MOST EXPENSIVE ENERGY SOURCE. REAL FOSSIL FUEL PRICES HAVE DECLINED SIGNIFICANTLY SINCE THE EARLY 1980'S, BUT AVERAGE ELECTRICITY PRICES HAVE REMAINED CONSTANT.

While the effect of the oil shocks of 1973 and 1978 on Washington energy prices was dramatic, it was relatively short-lived. Petroleum prices increased by 50 percent in 1974, increased by another 63 percent between 1978 and 1981, and then quickly settled back to pre-1973 levels. Real natural gas prices have followed a similar trend, rising steeply during the 1970s, falling during the 1980s, and staying relatively stable in the 1990s. The average price of electricity, which had been low and stable for years, increased by 95 percent between 1979 and 1984 as the costs of new, large power plants, some of which were never completed, were incorporated into electric utility rates. In contrast to oil prices, real electricity prices have not declined from the level they reached during the early 1980s.

The price increases for all fuels caused real Washington energy expenditures to climb by 56 percent between 1978 and 1982. Expenditures were 25 percent lower by 1986 as the price of fossil fuels plummeted, but have since climbed back near the levels of the early 1980s, as energy consumption has increased.

21. Energy Price Trends – Average Energy Prices by Sector

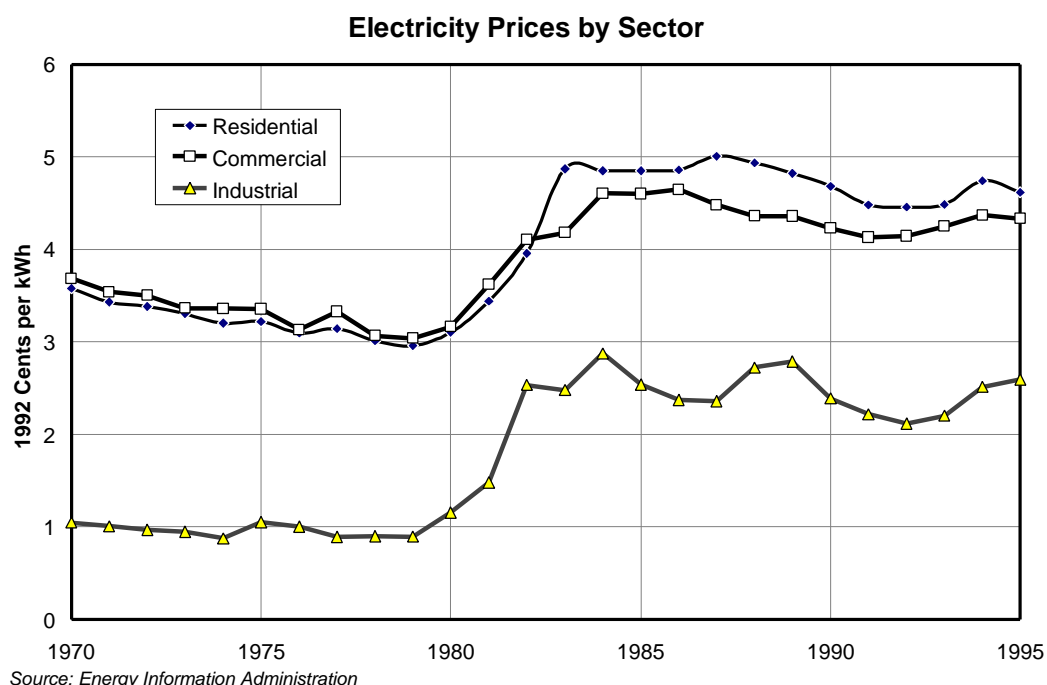


AVERAGE ENERGY PRICE TRENDS BY SECTOR IN WASHINGTON REFLECT THE MIX OF FUELS USED IN EACH SECTOR: ELECTRICITY AND NATURAL GAS IN COMMERCIAL AND RESIDENTIAL BUILDINGS, PETROLEUM FOR TRANSPORTATION AND A MIX OF LOWER COST FUELS IN THE INDUSTRIAL SECTOR.

As in the rest of the country, average energy prices in Washington peaked in the early 1980s and have since declined steadily. The trends have been similar, but not uniform across end-use sectors. The industrial sector bore the brunt of increasing energy prices in the 1970s, but has enjoyed a 35 percent decrease in real energy prices since 1985. Residential and commercial sector prices increased less in relative terms in the 1970s, but have since fallen only slowly. The prices of transportation fuels peaked in 1982 and have fallen steadily since.

The price trends depicted are mainly a function of the fuels used in each sector. The fuel mix has been similar for the residential and commercial sectors since 1970, accounting for the almost identical price trends. Industrial energy prices are lower for several reasons: the sector is much less reliant on electricity, which is expensive relative to other fuels; inexpensive biofuels account for 20 percent of industrial energy consumption in Washington (but only 3 percent of energy expenditures); and larger customers tend to pay a lower price for each fuel. Transportation fuels are almost exclusively petroleum-based — prices in this sector rise and fall with the global price of crude oil.

22. Energy Price Trends – Average Electricity Prices by Sector

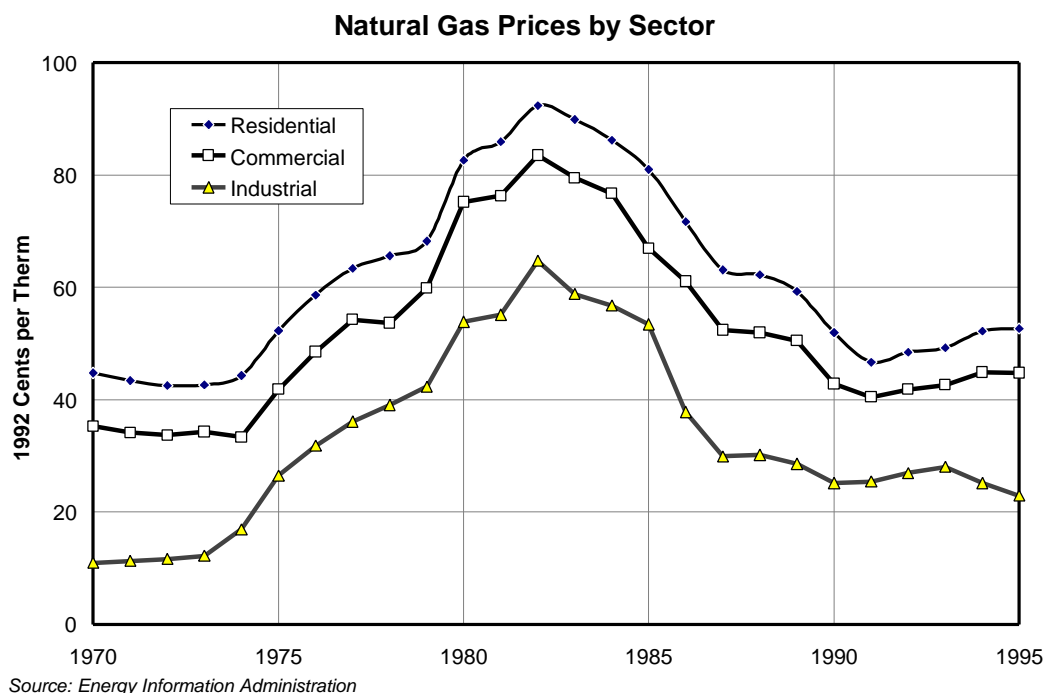


REAL ELECTRICITY PRICES INCREASED DRAMATICALLY BETWEEN 1979 AND 1984. THE MAGNITUDE OF THE INCREASE WAS SIMILAR FOR ALL SECTORS, BUT THE RELATIVE INCREASE WAS MUCH HIGHER FOR THE INDUSTRIAL SECTOR.

The most notable phases in electricity prices are the long, slow decline of prices in the 1970s, the rapid increase between 1979 and 1984, and the period since 1984 when no trend is evident. Price trends for the residential and commercial sectors are nearly identical. Industrial sector prices have been more volatile than residential and commercial prices, increasing over 200 percent between 1979 and 1984, versus 50-60 percent for the residential and commercial sectors. On a per unit basis, however, the increases were similar for all sectors: 1.9¢ per kWh for the residential sector, 1.6¢ per kWh for the commercial sector, and 2.0¢ per kWh for the industrial sector.

Industrial prices have fluctuated as much as half a cent per kWh from year to year during the 1980s and 1990s. This may have as much to do with world aluminum prices as it does with Northwest electricity prices. Aluminum smelters, which account for nearly half of industrial sector energy consumption in Washington, paid electricity prices contractually linked to aluminum prices for much of the time period depicted.

23. Energy Price Trends – Average Natural Gas Prices by Sector

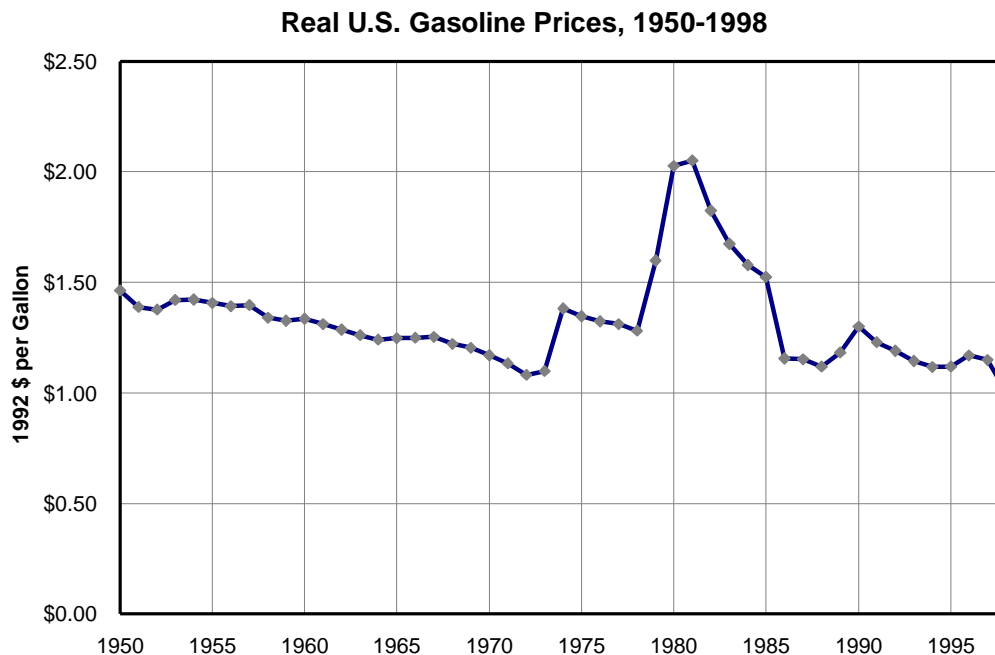


NATURAL GAS PRICES INCREASED RAPIDLY FOR ALL SECTORS BETWEEN 1974 AND 1982 AND DECLINED JUST AS RAPIDLY FROM 1982 TO 1991. INDUSTRIAL SECTOR GAS PRICES HAVE DECLINED SINCE 1993, WHILE RESIDENTIAL AND COMMERCIAL RATES HAVE SEEN MODEST INCREASES.

Price trends for natural gas have been much more uniform across sectors than for electricity. For all sectors, real prices were stable in the early 1970s, increased rapidly between 1974 and 1982, and declined just as rapidly between 1982 and 1991. As with electricity, the price increases during the 1970s were of similar magnitude in all sectors on a per unit basis, but were much larger in percentage terms for the industrial sector. Real natural gas prices increased by approximately 50¢ per therm for all sectors between 1973 and 1982.

Price trends have diverged since 1993. Residential and commercial customers have seen price increases of 7 percent and 5 percent, respectively, between 1993 and 1995. Average industrial sector natural gas prices declined by 18 percent over the same time period. Many large industrial customers have begun to make bulk purchases of commodity gas from suppliers other than their local utilities.

24. Energy Price Trends – U.S. Gasoline Prices since 1950



Source: Energy Information Administration's Annual Energy Review

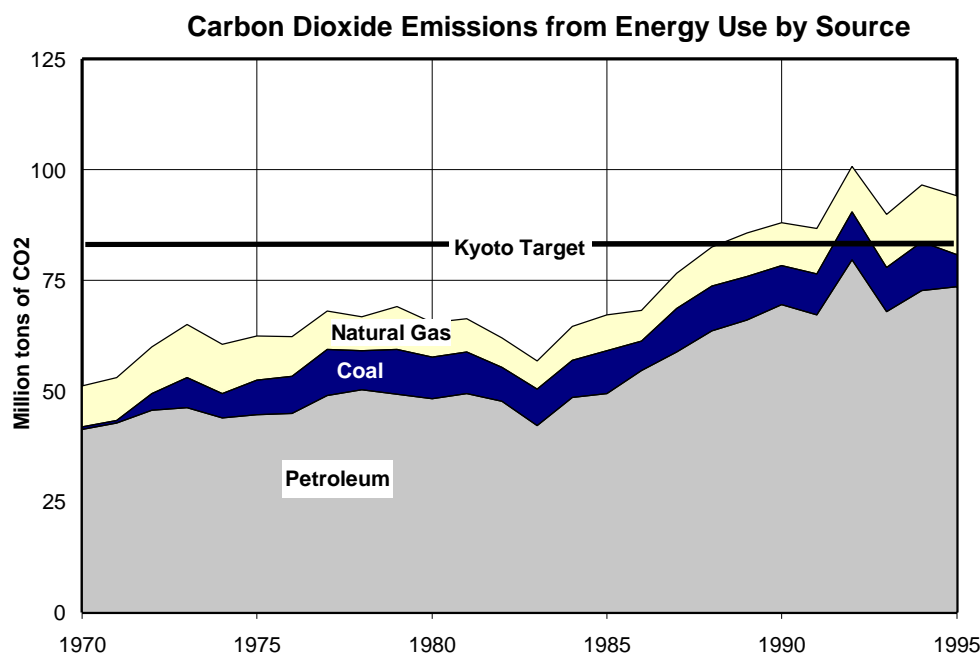
Data Note: 1998 value is an estimate based on data for January-October.

ADJUSTED FOR INFLATION, GASOLINE COSTS LESS TODAY THAN AT ANY TIME IN HISTORY. EXCEPT FOR A PERIOD OF PRICE INCREASES ASSOCIATED WITH THE OIL SHOCKS OF THE 1970S, THE LONG-TERM TREND IN GASOLINE PRICES HAS BEEN A SLOW AND STEADY DECLINE.

In the spring of 1996, U.S. gasoline prices surged from less than \$1.20 per gallon in February to \$1.40 by May, attracting a great deal of attention from consumers, the media, and even Congress.⁵ Two years later, it is apparent that this was a minor departure from a long-running trend of declining gasoline prices. Gasoline prices in 1998 were the lowest on record.

Except for the brief period of OPEC unity, which lasted from 1973-1985, gasoline prices have declined slowly and steadily since 1950 as new fields have been discovered and improved technology, and infrastructure have reduced the cost of extracting, transporting, and refining crude oil. Prices plunged when the OPEC agreements fell apart in 1985, and despite minor blips caused by the Iraqi invasion of Kuwait in 1990 and the unusual events of the spring of 1996, the 1990s have once again seen falling gasoline prices. Adjusted for inflation to 1992 dollars, a gallon of gasoline cost \$2.03 in 1980, \$1.17 in 1970, and \$1.46 in 1950, as compared to \$1.00 through the first ten months of 1998.

25. Environmental Trends – Energy-Related Greenhouse Gas Emissions



WASHINGTON'S INCREASING RELIANCE ON FOSSIL FUELS HAS LED TO STEADY GROWTH IN EMISSIONS OF CARBON DIOXIDE, THE PRINCIPAL GREENHOUSE GAS. PETROLEUM USE, PRIMARILY FOR TRANSPORTATION, ACCOUNTS FOR OVER 75 PERCENT OF CO₂ EMISSIONS IN WASHINGTON.

Washington's continued dependence on fossil fuels for energy, particularly petroleum, has led to rapid growth in emissions of carbon dioxide (CO₂), the principal "greenhouse gas" contributing to global climate change.⁶ After dipping in the early 1980s, growth in carbon dioxide emissions accelerated after 1983 as the economy recovered from recession and oil prices plummeted. Washington's CO₂ emissions grew by 3.4 percent per year between 1985 and 1995.

Consumption of petroleum products, the vast majority for transportation, accounts for over three-quarters of Washington's CO₂ emissions. Emissions from coal are almost entirely from one source, the Centralia Steam Plant which burns coal to produce electricity. Emissions from this source declined sharply in 1995, as the plant was kept idle during much of the year due to low electricity prices. Natural gas contains less carbon per unit of energy than other fossil fuels, but still accounts for a larger share of Washington's CO₂ emissions than coal.

Also depicted is the emission target agreed to during the Kyoto negotiations in 1997, which is 7 percent below 1990 levels. Meeting this target would require a 15 percent reduction from Washington's 1995 emissions level.

Notes

¹ The difference between primary and end-use energy consumption is the treatment of electricity. Electricity must be generated using energy sources such as coal, natural gas, or falling water. These *inputs* to the power plant are counted as primary energy; the *output* of the power plant that is sold to homes and businesses is end-use electricity. Since two-thirds of the energy inputs to thermal power plants are typically lost as waste heat, primary energy is larger than end-use.

² The U.S. portion of the Northwest Power Pool includes Washington, Oregon, Idaho, Utah, northern Nevada and the parts of Montana and Wyoming that are part of the Western Interconnection.

³ The Western Interconnection refers to the geographical area encompassed by the interconnected western transmission grid. It includes all or most of Washington, Oregon, Idaho, Montana, Wyoming, Utah, Nevada, Colorado, New Mexico, Arizona, California, the Canadian provinces of British Columbia and Alberta, and the Mexican state of Baja California Norte. It also includes small portions of Texas, Nebraska, and South Dakota.

⁴ Official, EPA-rated fuel efficiency. The Energy Information Administration estimates actual, on-road performance to be 17.5 percent worse than the EPA rating (EIA, *National Energy Modeling System*, Fuel Economy Degradation Factor). This means that new vehicles sold in 1996 can expect to average 20.0 miles per gallon, as opposed to 24.3 estimated by EPA. This is very close to the average, on-road fuel efficiency of the nation's existing stock of light-duty vehicles, which is estimated to be 19.7 MPG (Oak Ridge National Laboratory, *Transportation Energy Data Book*).

⁵ For a discussion of the 1996 gasoline price increases, see the May 24, 1996 letter from Washington State Energy Office Director Judith Merchant to Governor Mike Lowry at <http://www.energy.cted.wa.gov/LETTERS/960524.htm>.

⁶ Technical note: These estimates include emissions of greenhouse gases due to the use of petroleum coke as a reactant in industry, which is arguably not "energy-related". However, there are some additional energy-related emissions of greenhouse gases not due to the combustion of fuels that are not included in this indicator. These include releases of methane (CH₄) from coal mining and natural gas pipeline leakage and nitrous oxide (N₂O) released from catalytic converters used on light duty automobiles. These emissions accounted for about 6 percent of Washington's total, energy-related greenhouse gas emissions in 1995.